On-Line Training Program

Module 4a

How do the vehicles work in an AGV system?

AGVS Product Section

of

MHI

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AGVS Automatic Guided Vehicle Systems

How do the vehicles work in an AGV system?

- How do vehicles know where they are going?
- Will vehicles operate safely in my facility?
- Will vehicles be able to move the loads?
- How are the vehicles powered?
- How maneuverable are the vehicles?
- What type of controls are on the vehicle?

How do the vehicles know where they are going?

Typical navigation systems for AGVs

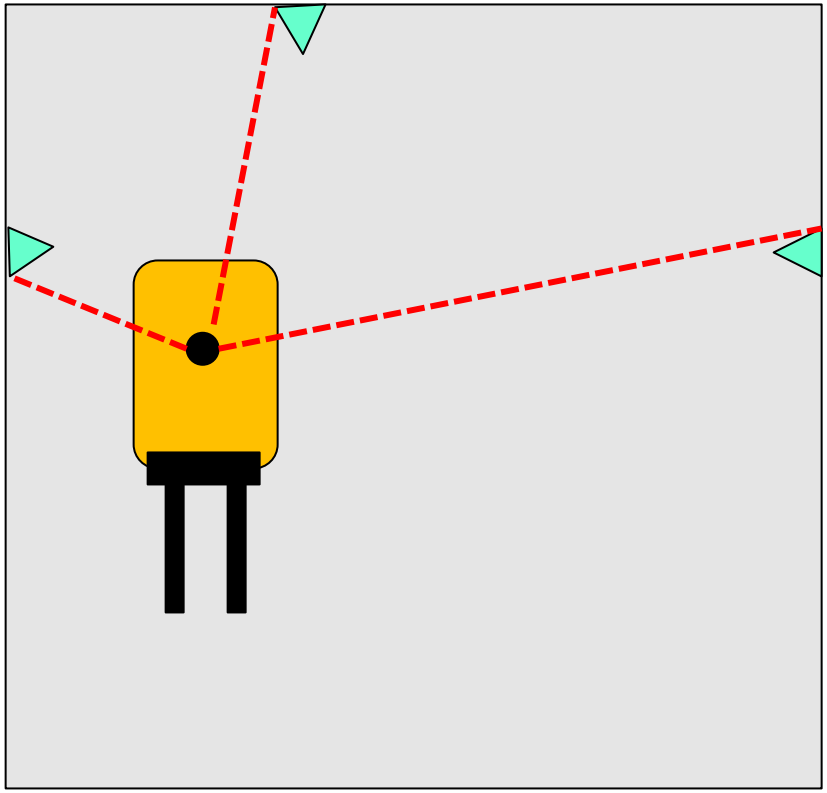
- Laser triangulation
- Inertial
- Magnetic tape
- Magnetic grid
- Natural feature
- Wire
- Optical

On certain applications more than one form of navigation may be used by a vehicle

How do the vehicles know where they are going?

Laser triangulation navigation systems

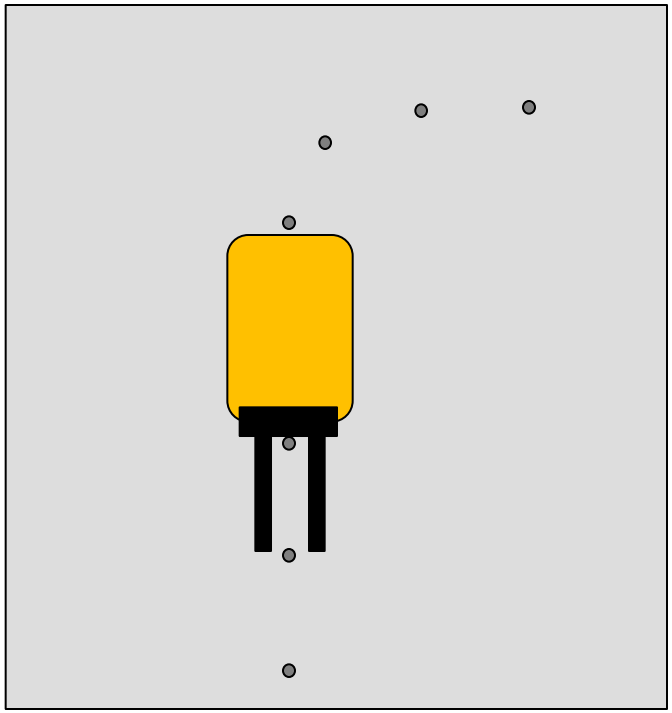
- Most popular method of AGV navigation
- Reflective targets are mounted throughout the facility at known positions
- A laser scanner is mounted on top of the vehicle
- The laser scanner strobes for reflective targets
- The vehicle control algorithms calculate the exact vehicle position via triangulation



How do the vehicles know where they are going?

Inertial navigation systems

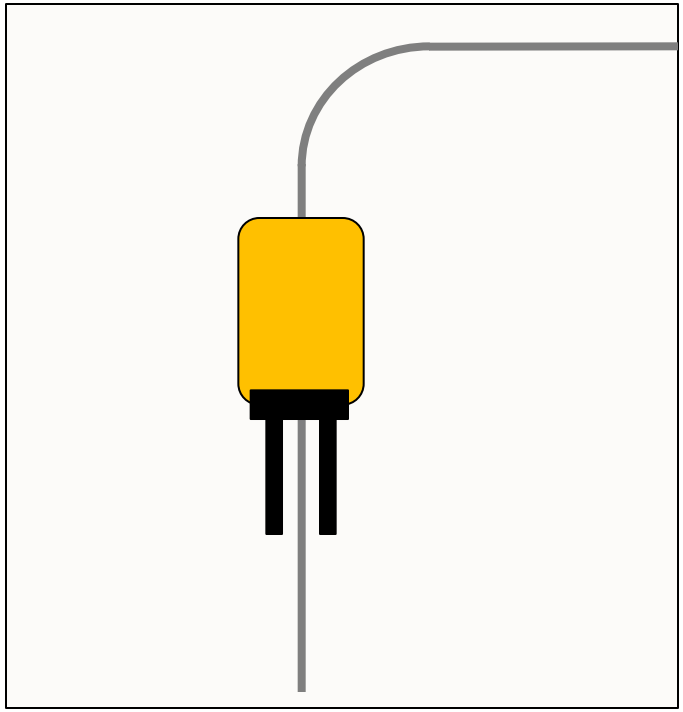
- Reference points (often magnets) are embedded in the floor at certain x,y coordinates in a map of the system
- Reference points are detected by a sensor on the vehicle as it passes over the reference point
- A gyroscope on the vehicle measures/maintains vehicle's heading
- A wheel encoder on the vehicle calculates the distance traveled
- Vehicle uses feedback from all three devices to determine location



How do the vehicles know where they are going?

Magnetic tape navigation systems

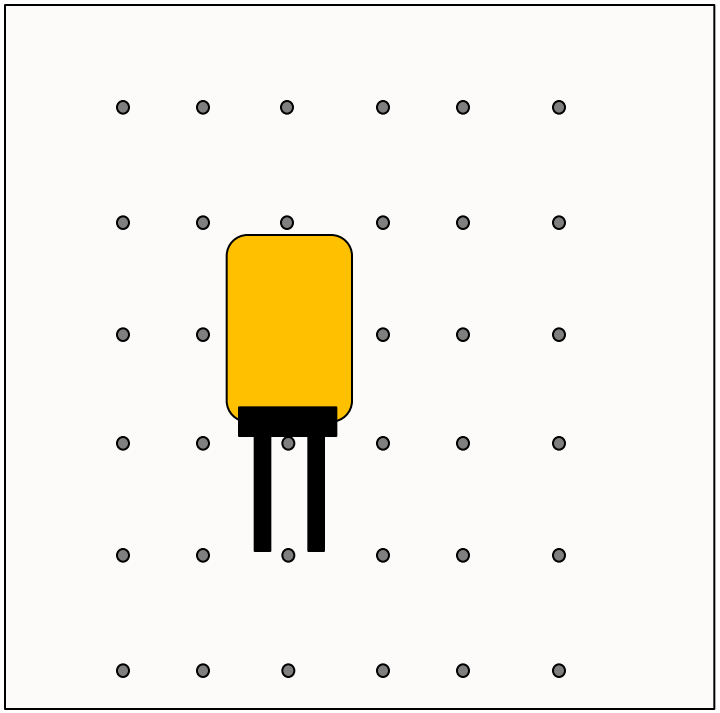
- Magnetic tape is adhered on the surface of the floor
- A sensor on underside of vehicle detects the magnetic tape
- Can operate off tape path via dead reckoning
- Similar to wire guidance (described on future slide)



How do the vehicles know where they are going?

Grid Navigation Systems

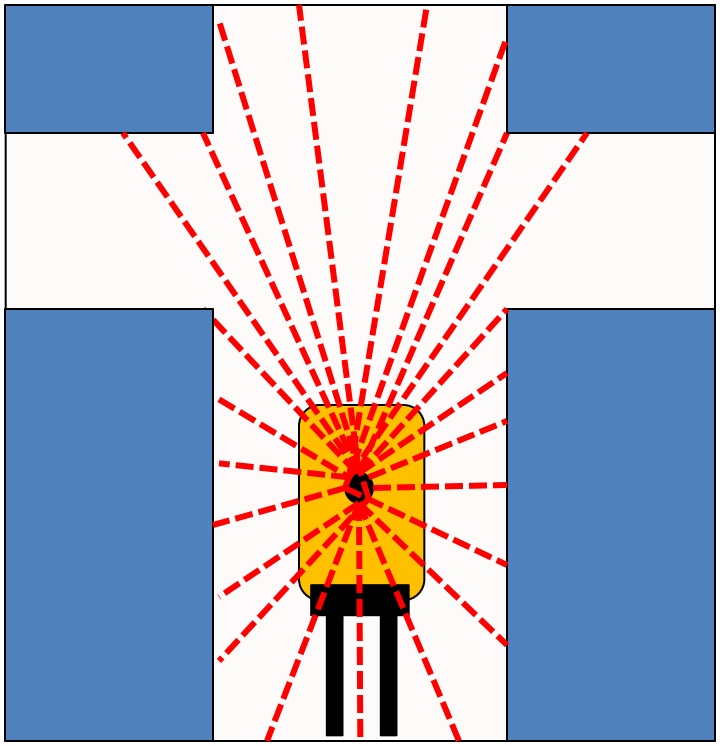
- Reference points (often magnets) are embedded in the floor in a grid pattern in the operating area
- Reference points are given x,y coordinates which are stored in the vehicle's memory
- The reference points are detected by an on-board sensing device
- A gyroscope on the vehicle measures/maintains heading
- A wheel encoder on the vehicle calculates the distance traveled
- Vehicle uses all three devices to determine location



How do the vehicles know where they are going?

Natural feature navigation systems

- Reference images of the operating area are recorded and stored in the vehicle's memory
- Uniquely identifiable, naturally occurring features are identified in the operating area
- Vehicle's actual position is calculated based on its relative position compared to those natural features
- A camera or laser can be used to record features during setup and sense features during navigation



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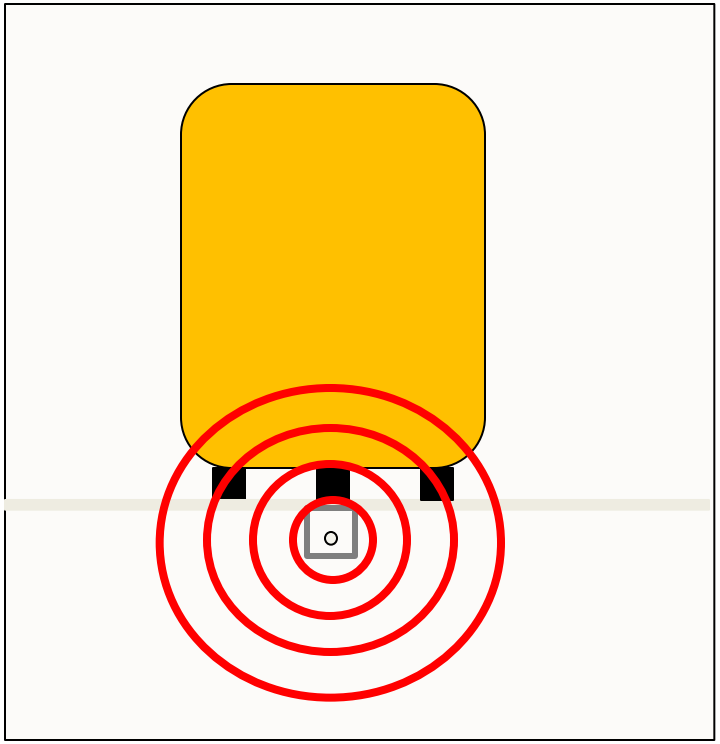
How do the vehicles know where they are going?

Wire navigation systems

- Navigates using a continuous wire embedded in the floor
- Antennas located on the vehicle detect signal from the wire
- Uses encoders on wheels to calculate distance
- Typically used in retrofits, system replacements and expansions



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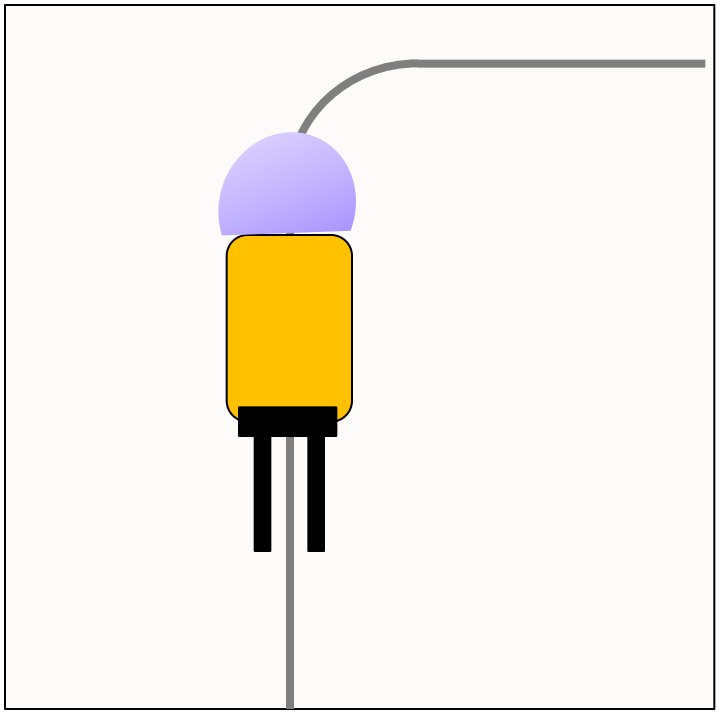
How do the vehicles know where they are going?

Optical navigation systems

- Chemical or tape strip is fixed or painted to the floor
- Vehicle has an onboard sensor which allows it to detect the path
- Some systems use an ultraviolet (UV) light source under vehicle to illuminate the strip which may not be visible with non-UV lighting
- Not typically used in plants or warehouses because floor line needs to be cleaned or reapplied



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Will vehicles operate safely in my facility?

- Obstacle detection
  - Laser obstacle detection
  - Mechanical bumpers
- ANSI standard B56.5
- Training personnel

Will vehicles operate safely in my facility?

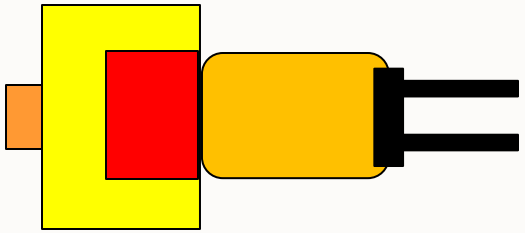
Laser obstacle detection

- Safety rated laser sensor on the vehicle detects objects in the vehicle path, bringing the vehicle to a safe stop before contacting the obstacle
- Typically uses 2 fields at all times – one larger warning/slowdown field and one stop field
- Multiple field pairs can be defined with each having different sizes and shapes for maximum protection – large fields when vehicle is moving faster, small fields when vehicle is moving slower, asymmetrical fields when the vehicle is turning
- The applicable field pairs are changed as the vehicle travels along the path to provide maximum protection corresponding to the vehicle movement

Will vehicles operate safely in my facility?

Laser obstacle detection

Vehicle approaches obstacle



Obstacle

Warning zone

Stop zone

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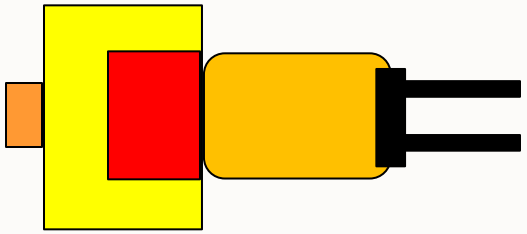
Will vehicles operate safely in my facility?

Laser obstacle detection

Vehicle slows and sounds horn as obstacle enters warning zone.

Vehicle stops as obstacle enters stop zone



Obstacle

Warning zone

Stop zone

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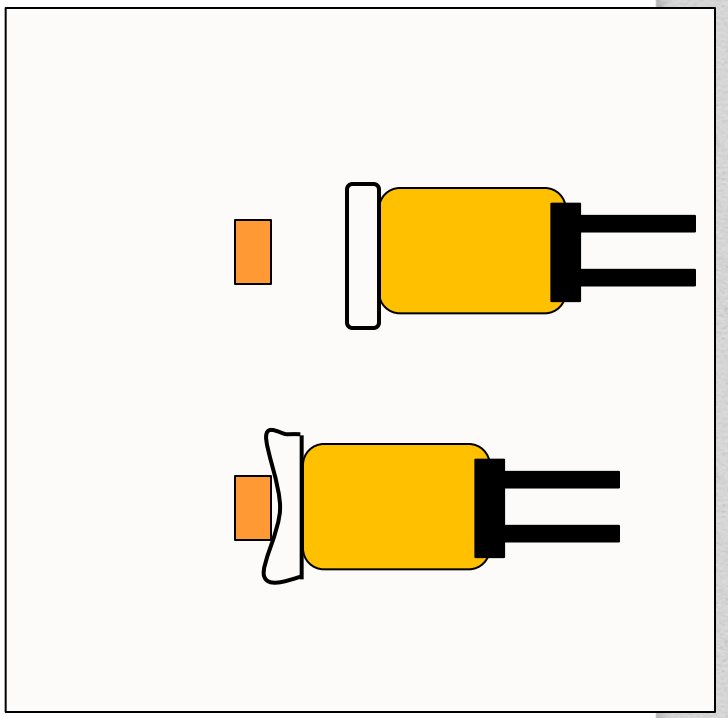
Will vehicles operate safely in my facility?

Mechanical bumpers

- Uses a limit switch to stop operation of vehicle when it contacts an obstacle
- The detection field is typically a plastic, flexible metal, or foam bumper material that will compress/collapse when contacting the obstacle and activate the limit switch
- Has fixed bumper size/shape and bumpers that may require maintenance and replacement
- Will push light materials such as waste materials out of the path of vehicle
- Less affected by dirt/dust than laser bumpers



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Will vehicles operate safely in my facility?

ANSI B56.5 provides guidelines regarding vehicle safety

ANSI/ITSDF B56.5-2012

Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles

An American National Standard

International Truck Standards Development Foundation

The complete standard can be downloaded at www.itsdf.org

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Will vehicles be able to move the loads?

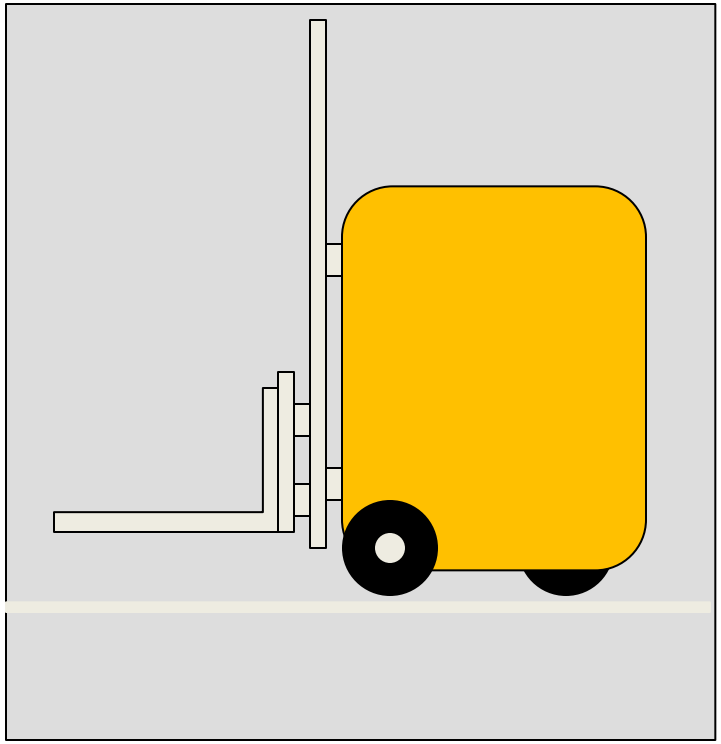
Vehicle types

- Masted vehicles – forked, clamp,single-double
- Unit load - lift deck, conveyor
- Tow or tuggers
- Carts
- Custom

Will vehicles be able to move the loads?

Masted vehicles

- The most flexible vehicle type
- Able to interface with the floor and block stacking, racking, stands and conveyors
- Resemble typical manual lift truck models (counterbalanced, reach, outrigger)
- Can be fitted with typical manual lift truck load handling attachments (forked, clamp, single/double)



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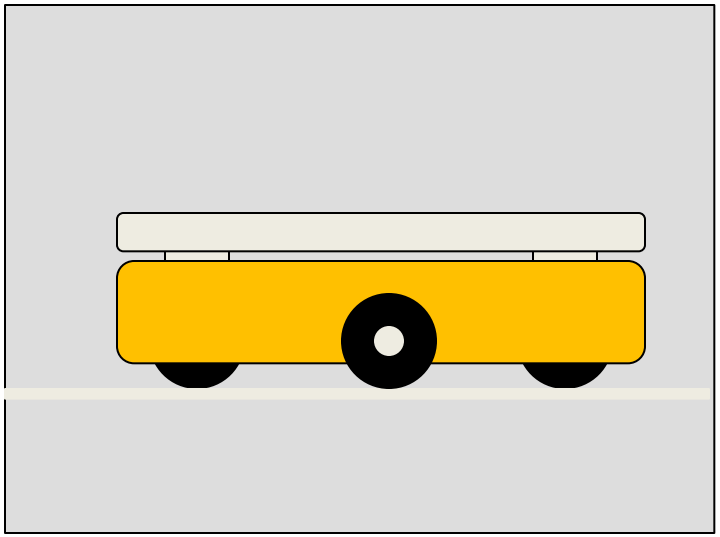
Will vehicles be able to move the loads?

Unit load vehicles

- Very compact design with vehicle typically directly under the load
- Able to interface with stands, and conveyors
- Load handling typically via conveyor or lift on the top of the vehicle
- May have no load handling ability if loaded/unloaded by external means (crane, etc)



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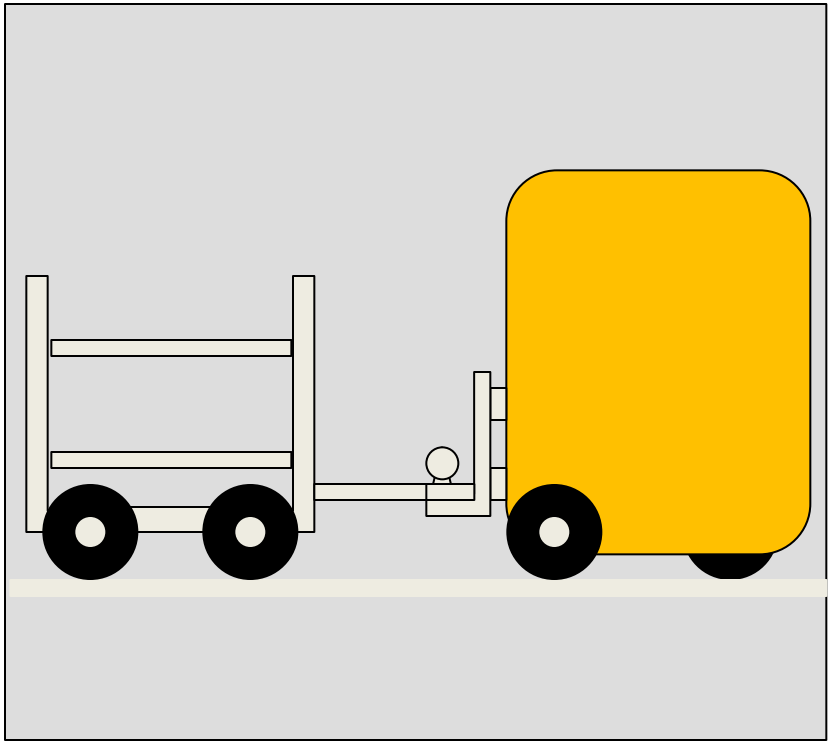
Will vehicles be able to move the loads?

Tow vehicles

- Sometimes called tugger vehicle
- Tows several (typically up to 3) wheeled carts
- Loads must be placed on and off carts manually or via some other automated machinery
- Provides most economical solution (fewer vehicles) than solutions where only one load is carried per trip



Will vehicles be able to move the loads?

Carts typically have some/all of the following factors

- Magnetic tape navigation
- Light loads < 2,000 lb
- Simple, looping type road systems
- No host computer
- Very simple or no traffic control
- Battery swap
- Light-duty construction
- Tow the load or very simple load handling

Will vehicles be able to move the loads?

Custom vehicles

- Designed to move unique loads
- Size, shape and capacity can vary considerably
- More commonly used in support of manufacturing to move work-in-process or finished goods

How are the vehicles powered?

Types of batteries, inductive power and fuel cells

- Most common batteries
  - Flooded lead acid
  - Sealed batteries
  - NiCad
  - Lithium ion
- Inductive power – vehicle receives power from plate(s) embedded in the floor. Used in some applications that require less flexibility
- Fuel cells – performing well in limited scale use in AGVs. ROI and refilling infrastructure can be a challenge
- The best choice of battery is based on your application. Talk to your AGV supplier to determine which battery is best for your application.

How maneuverable are the vehicles?

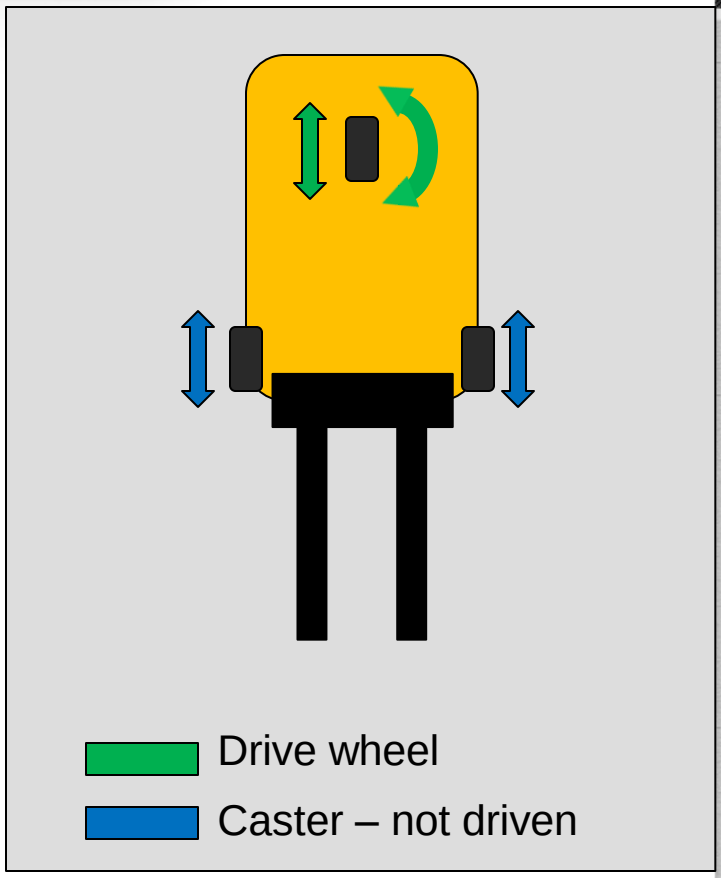
Drive configurations

- Defined by the arrangement of wheels on the vehicle and by which wheels are driven and have steering
- Determines the maneuverability of the vehicle
- Also affects the vehicle complexity and cost
- Most common types include tricycle, differential, quad, and other

How maneuverable are the vehicles?

Tricycle drive

- Most common on AGVs
- Provides precise vehicle tracking
- Maneuverability acceptable for most applications



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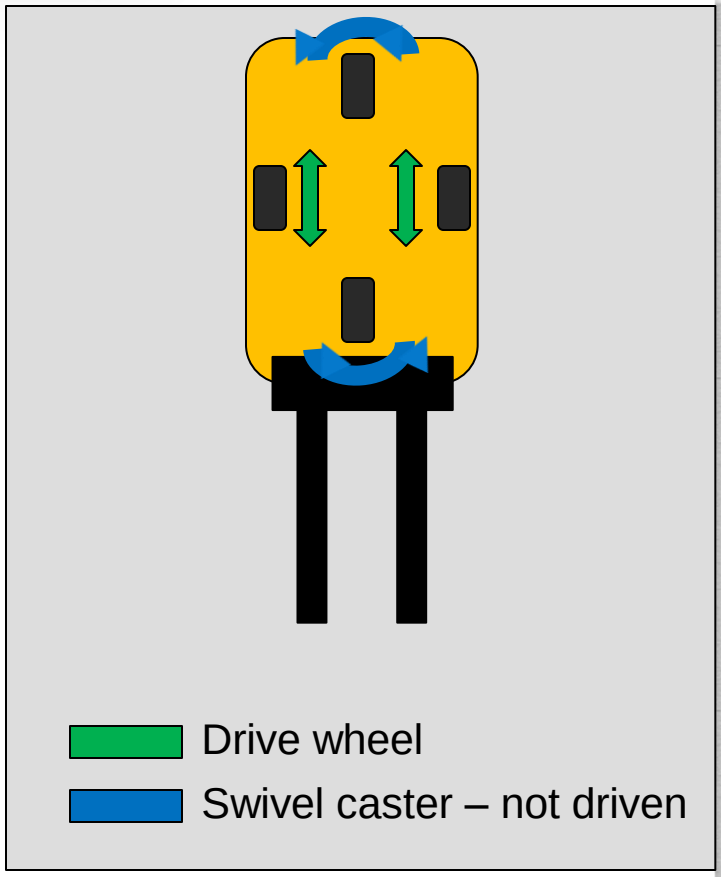
How maneuverable are the vehicles?

Differential drive

- Steers using differential speed/direction of drive wheels
- Maneuverable – can rotate around the center of the vehicle
- Common on older unit load vehicles
- Vehicle angular positioning less precise



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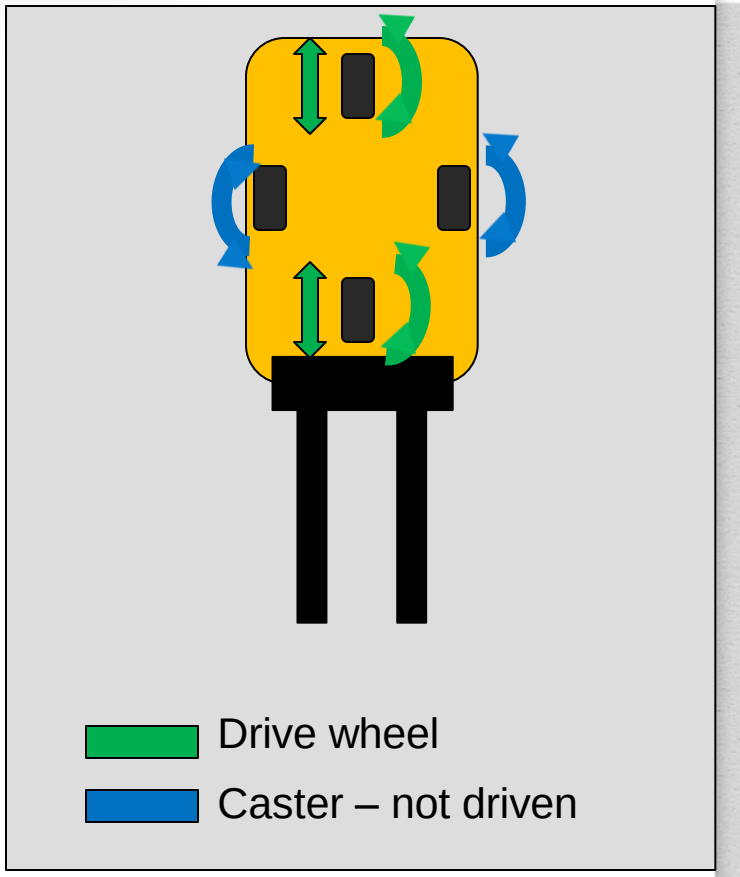
How maneuverable are the vehicles?

Quad drive

- Two steer and drive motors
- Maneuverable – can rotate around the center of the vehicle and move sideways
- More complex than other drive configurations



How maneuverable are the vehicles?

Other drive configurations

- Special drive arrangements can be used to provide for unique applications requiring
  - high capacity
  - limited wheel /floor loading
  - other environmental conditions

What type of controls are on the vehicles?

Vehicle controller– PC-based or other controller in the vehicle that includes processor and I/O to provide navigation, communication and operation of the vehicle

Manual controls – Allows manual operation of the vehicle

Maintenance/Operator interface – provides calibration, troubleshooting, verification of vehicle parameters

Motor (AC or DC) – motors that provide steering and x,y vehicle movement

Motor controller (AC or DC) – provide the control signal to the motors for vehicle movement

What type of controls are on the vehicles?

Navigation controls – provides real time feedback on actual vehicle position for navigation of the vehicle in the facility

Load position verification sensors – sensors mounted to the load handling attachment to make sure that the load is positioned correctly during vehicle operation

Interface "handshake" sensors - sensors mounted on the vehicle and interface equipment that provide communication link to ensure smooth load transfer

Obstacle detection sensors – sensors on the vehicle which bring the vehicle to a safe stop before contacting any obstacle that it may encounter in its path

For More Information:

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